

MAKING FOLDING KNIVES

By Harold Hoffman

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If you want to learn how to make custom knives, folding knives, or spring back knives, this book has all the information that you will need. It is an excellent book for the beginner or advanced craft person.

This book has drawings, and photos that you can follow step-by-step as you make your first knife.

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Zaibatsu Release

I am the alpha, the omega, the beginning and the end



ABOUT THE AUTHOR

Harold Hoffman has through his 30 plus years of experience as a Gunsmith, Toolmaker and Custom Knife maker has passed on to you through his books information that soon may be lost or forgotten. His books are not intended for the person wanting to make a complete firearm, but for learning basic shop tool making. The information found within his books is for instructional purpose only. -- The titles DO NOT actual cover gun repair on firearms, but how to make needed parts for firearms which is about 40% of all gun repair. Without this information you will be severely limited in gun repair.

He first started gun repair when he was 18 years old doing minor repair for the farmers and local hunters in the Bucklin, Kansas area. His main interest was how to make rifle barrels, as he was an avid hunter. Moving into a bigger shop he bought a lathe and proceeded to learn how to use it.

He wanted to find out how to make rifling buttons to rifle barrels, tool making, and learn everything about making barrels. Over the years he became an expert toolmaker and how to build most everything that was needed in the shop. The information found in his books will show you how to make most of the equipment and tools needed in most shops.

After an eye accident he quit Gunsmithing and started writing books on everything that he knew. He had so much difficulty finding any information that he wanted all this information that he had learned in over 30 years to be available to everyone otherwise it would be lost.

His books are now about the only books available on Gunsmithing/Tool making, as most publishers do not publish Gun or Gunsmithing books anymore.

PREFACE

Make your own knife? Now, that may sound strange to most people. Why would you want to do this, when there are so many low price and attractive knives for sale?

Many people have asked me this many times. Most people are satisfied with a small knife that they can carry in their pocket that is used to clean their fingernails, open envelopes, etc. Others want a hunting knife that they can pry or pound on in splitting out game, and if they lose it, so what, it did not cost much.

The small majority of people look at a knife as a very important tool, one to take care of, and always have available. These people want a knife that will last a long time, or a lifetime. They also want a knife that will hold an edge, and sharpens easily.

Most of the individuals that make knives, or are thinking about making knives, are not totally satisfied with the knives that are available. Making their own is one way to get what they want.

This book is about making fix blades, folders, spring backs and Lock backs. I will show the reader how to make these knives in this book, as well as many other processes that will be useful as well as save you much time. I also go into the advance phase of the Knife Makers art that includes casting of special parts and fittings. This will allow a higher profit margin on duplicated knives.

Using simple templates that can be easily made in the shop, I will show the reader how they can easily make one or a dozen knives, this method eliminates hours of work on the knife. After making a few knives, you will be able to make a first class folder in eight hours or less.

The equipment needed is not that expensive, and most people that like to make things will have some of the equipment that I will describe in the next chapter.

Each knife that you build can be a beauty, and a work of art, and it will surprise you of the beauty and the uniqueness of the knives you build. They are sleek and graceful, and you can build each with your personal touch.

I do not normally go into the making of fix blade or art knives, but the casting of special parts will be valuable to you in this area. I made most of my knives as fix blades for more than thirty years. I started make folding knives about 10 years ago and from that time on have made nothing but folding knives. Folding knives are much easier than ridged knives for me, and more useful.

Do not let other knife makers discourage you from making folding knives? Many that I have met have told me they tried to make one and it took twice as long to make as a fix blade. They are right, for if you try to make a folding knife, using the same methods as making a fix blade, it will take a long time.

The secret is as stated above is the template.

I make the template from 1/16 tool steel, fitted as you would a regular knife, and heat-treated. Once this is done, I just take minutes to fit a knife. Without this template, it would take hours.

Another advantage in making your own knife is that you can select the steel that will meet your

requirements. After heat-treating the blade, you can draw the blade (temper) to meet your requirements.

This book will give you all the basic as well as advanced instructions that you will need, and it will tell you how to make some tools that you need in the shop.

Harold Hoffman

FORWARD

Knives have long interested and fascinated me. When I made my first knife, I was about five years old that I whittled out of a wood lath. For forty or more years, I have made various knives in my spare time. This is a text version only.

In my rifle barrel manufacturing business, in Kansas, I would make various knives from time to time, and as a tool and die maker, making knives was easy for me. I have worked with just about every type of tool steel that is available, and my metal working experience is very extensive. All tools, reamers, etc. that I needed, I made in the shop. Working with metal, a person can design and build various objects of art. Most people believe that metal is difficult to work with. With a little practice and determination almost anyone can make a knife, and by following the instructions can build folding knives.

If a person would like to learn to build folders, do not let other knife makers discourage you by saying they are too difficult to make. All it takes is a little time and practice to develop perfection.

After making dozen or so knives, you will be making quality knives that are a work of art. All that is required to be a good knife maker is that **YOU STICK WITH IT UNTIL YOU LEARN**.

EQUIPMENT NEEDED

So you are serious about getting started making knives. I know some knife makers that started with a hacksaw and an electric grinder. These were the hard nose knife makers, who gathered up some old files and ground them into first class knives.

I have made several knives this way, with good results, but this is the hard way. You have to be very determined or you will soon lose interest in making knives this way.

If you want to start right, the first piece of equipment that you will need is a drill press. The drill press can be a table or one that is on its own stand. I prefer the one that is on its own stand, as it can be set just about any place.

I use a Sears's craftsman drill press. They have as good a model as any, and what is more important is that you can find parts for it if it breaks down. In addition, Sears carries many accessory items that can be added to it. If you buy the heavier model, you can get a milling vice that will bolt on the table. This will let you turn the drill press into a light-milling machine, but usually you will never need this option, but try to get one that has many speed settings.

Another handy item is a vise. You cannot appreciate how important it is until you are holding an object with your fingers, and have it jerked from your grip.

Usually what, happens is that, (1) you cuss, (2) you shut off the machine, and (3) you head for the first aid kit, dripping blood all over the floor.

You will also need a box of numbered drill bits, and the standard decimal sizes. The numbered bits are the main ones that I use in knife making. The nickel silver rod and wire used to pin the knives, is never the same size, so you have to drill to suit.

A small metal countersink should complete the hardware necessary for the drill press.

You need an anvil of some sort on the workbench. When you peen the blades in the knife it is set on the anvil, so the knife maker's anvil is a handy item also. It will allow you to put new pins in the handle without taking the knife apart.

I use the Sears 6 by 48-inch belt sander, and a smaller four by thirty-six model. I consider these belt sanders to be one of the most important pieces of equipment in the shop. They have a round disk sander that I use to cut 45-degree angles on my bolsters. On the bigger sander, it uses a 9-inch disk.

You can get three different grits of belts from Sears, but I get most of my belts from WHOLESALE TOOLS, as they have more than ten different grits from which to choose. If you buy in quantity, the cost goes down quite a bit. You will need grits from 36 to 220. You will find that the belt sander will be the main tool to give you the very close fit for which you will strive.

In addition, you will need a good metal cutting band saw and the band saw is used more than just about any piece of equipment, except the blade grinder.

The band saw that you buy, needs to have a speed reducer, its function is to reduce the speed for

cutting metal. Without this, you would burn the teeth right off the blade. If you buy a Sears band saw, they sell speed reducers for cutting metal. Use 14 -18-tooth blades for metal cutting.

The next piece of equipment that is necessary is a knife grinder. I have looked over several, and have two. The WILTON SQUARE WHEEL GRINDER is I think the best of the knife grinders. You can get many accessories for it, which makes it a very handy and fast machine. It uses a two by 72-inch belt, and comes in grits from 36 to 600. Normally an assortment from 36 to 320 is all that is necessary to make knives. I only use it to grind the blades and radius the handles. It will be a scary piece of equipment to use as first, as it runs very fast. Always wear some type of protective eye shield when using the grinders. The belts have a way of flying apart at the most inconvenient time.

The Wilton grinder is used to hollow grind the blades. It can also be used to grind the blades and handles. In flat grinding blades, I prefer to rough it off with the Wilton, and then finish on the flat sanders.

This is not a necessary piece of equipment for knife making. I included it in case you have one, or can get one reasonable. If I have my choice of the drill press or milling machine, I would take the Milling machine. It will do everything.

I use a shaper to remove excess metal from knife stock, but what it will do, the milling machine will do much better. It does come in handy to remove metal, while you do other things. Again, this is not a necessary piece of equipment.

A lathe is not used too much in knife making. Where I use it, the most is making special size pins, for metric knives. At times, you have to make up special tools, and this is where it comes in handy, but having it is not necessary.

A good buffing wheel is also necessary. You can use a metal grinder to make a good buffer. If you have any old electric motors, you can get a mandrel that will make up an excellent buffer.

You will need at least two Buffing wheels. I like the eight-inch size, and you will need one loose buff to do the final finish on the handles. Use a full disc sewed buff for using coarser grit, to remove the scratches from the metal.

We need a good assortment of buffing compound, from 180 to 400 grits. Most of these can be purchase from knife suppliers. I however finish out my blades with 320 grits on the Wilton grinder, then bead blast the blades, to finish the surface. The reason for bead blasting the blades is that after going over them with a fine wire wheel I have a finish that holds up under everyday use. The wire wheel takes the roughness off the bead blast finish, and puts a satin finish on the blade. It is a very attractive finish, and holds up well.

If you want to use a bead blaster to get a satin finish on your knives, I am sure you will be pleased with it. The bead blaster can be purchase from Machine Supply Houses. Ranchers, Farmer, Hunters, and others, use many knives that I make. I had been using a High Polish Finish on the blades. After about six months, the blades were all scratched up from use, but my knife had a Satin Finish on it, and it too was well used, but not scratched up from use.

Over the years, I have used many different types of heat-treating furnaces. The electric furnace is by far the best for average use. If you are using Stainless Steel, it is almost a necessity, if you cannot read the temperature by color. If you are using 01-tool steels to make the blades, a gas-heating furnace works well. In a later Chapter, I will show you how to make one.

I heat-treat all of my knives in a gas blast furnace, and to protect the blades from decarbonizing, I use brazing flux as a coating to keep this from happening. This totally protects the metal from burning.

An acetylene torch is nice to have but not necessary, as there are usually many small parts that will need heat-treating. It is not a necessary item though. A butane torch works well also, but the heat is limited, and it works well for drawing the temper on small parts.

A good set of Dial Calipers is a necessity. A 0-1 inch Micrometers will do the same job, but a six or eight-inch Caliper is handier. When you start fitting the knives together, you have to know what the measurements are on each part. If you do not, you will have either a sloppy or a sticky knife.

A good small, but heavy built, vise is necessary. Most of the fitting is done while the parts are in a vise. The Vise needs to be the swivel type, as you will need to change the angle as you work on the knife.

We need a good bench grinder to sharpen dull drill bits. You can however do a good job of sharpening the bits on a belt grinder. A hand-held Grinder like a Dremel is very handy for fitting and finishing in small places. You can get many accessories for it, to help make your job easier.

Files are the main hand tools that you will use, as just about all the fitting will involve the file. You will need files from 6 to 12 inches. In addition, we will need a good set of needle files to finish sharp or narrow parts. They are also used in the file work on the back of the knife; this is called artwork, and is used to decorate the finish knife.

You will need a couple of small ball peen Hammers. Get the smallest size that you can find. They are used to peen the pins in the knife. You will need a slightly larger one for use in stamping the nail notch in the blade. This is a piece of Tool Steel shaped like the nail notch, and it is used to swedge the nail notch in the blade.

A good set of wire nippers is also necessary. They are used to clip the pins off that hold the knife together. The end nippers are by far the best, though side nippers will work just about as good.

You will also need to get a can of Dykem; it is used to coat the steel with ink so you can mark out the pattern of the knife that you are cutting out.

This is the standard tool grinder. We remove the stones and we put cardboard wheels on in place of the stones. When the knife is completely done, you use the belt grinder to rough it to shape the cutting edge for final sharpening. You then go to the cardboard wheels to finish the sharpening. We coat one wheel with fine carbide powder, and it is used to put a fine burr on the cutting edge. The other wheel is coated whit a fine buffing compound. This removes the burr, and puts a razor sharp edge to the knife.

On the blades that I make from 01 tool steel, I use a product called Marine Tuff. This is very similar to nickel plating. 01 tool steel rusts very easily, but as a knife blade material it is hard to beat as we can easily sharpen it and it holds an edge good. Marine Tuff eliminates the rusting problem, and puts a very thin coating similar to Nickel Plating (See chapter on Nickel Plating), and it is almost as hard and wear resistant as carbide. Electrolysis Nickel Plating works almost as good. This is not new, as some well-known knife manufactures had started using this many years ago.

There probably will be many other items and tools that you will need when you start making knives. In

the Appendix you will find the names and address of suppliers where you can get all the supplies you will need.

TYPES OF KNIFE STEEL

We class this tool steel, as cold works die steel; this grade of steel is the most common of tool steels. It is found in most tool and die shops, and is the workhorse steel for all tools.

It has a good manganese content that allows this steel to be oil hardened quench. 01 is a very stable steel, and you will find that you get very little warping or cracking that you would normally experience with other high carbon steels. See the charts for comparison of wear, hardness, etc. I would recommend this as a good starting steel, as using it is easy.

W2 is a carbon vanadium tool steel; it has a small amount of vanadium that helps to eliminate grain growth if it is over heated. We should regard it as water hardening carbon tool steel.



You can get W2 in various carbon contents, ranging from about .60 to 1.4 percent. If you use this steel, try to get a carbon content of at least 1.00 or above. This higher carbon content will make a harder blade.

We heat this steel to 1500 degrees, and quenched in a brine solution or water. A brine solution is my favorite as the steel comes out clean and bright after quenching.

The water or brine should be 100 to 125 degrees when you quench the blade. There is a trade off using water or brines, using these to quench the blades; you may get some warping.

The use of Carbon steel has one other advantage. You can draw the hardness on the back of the blade (or spine) to give the main part of the knife toughness, and leave the cutting edge hard.

Many people have access to saw blade material. In some areas, there is quite a bit of lumber work. The big saw blades make excellent knife blades. Most, but not all use an alloy similar to L6. The L stands for low alloy. What this means is that it is mainly a high carbon steel. It has a fair amount of nickel, and that is what gives it great toughness.

This steel has good wear resistance, and great toughness. It is an oil hardening steel. This material has more alloys added to it, and it is a better grade of steel. It has quite a bit more toughness and wear resistance over 01. With the 5 percent of chromium added, it has a mild corrosion resistance. Another draw back is that you need to go to a higher temperature for hardening (1,750-1800

degrees F.).



We should heat this steel to 1,400 degrees, rather slowly, and dipped in brazing flux. This is to protect it from decarburization. It is soaked at 1,400 degrees for fifteen minutes to relieve any stress, and then brought up to temperature. At 1700 degrees, we remove it from the furnace and cooled in still air.

We recommend that you leave extra stock on the blade for grinding any decarburization from the blade. If you want to get 2-3 point harder blades, you can use what they call a sub-zero quench.

You will not lose any toughness by doing this. What happens, is that at room temperature it will not convert all the austenite to martensite.

If you want to use this process, get some dry ice, put it in an ice chest and pack the blades with the dry ice.

This steel is used in cutting tools for metal, and it has a very hard and wear resistance cutting edge, but as with most special steels, it is rather expensive.

For special blades, this is a good choice.

When heat-treating it is IMPORTANT NOT TO HEAT IT MORE THAN 1600 DEGREES. If you should do this large grain size, with poor strength and wear will be the result.



This is another steel used in the machine shops for cutting bits for steel. This steel can be over heated when finish grinding without losing any hardness.



In heat-treating, leave plenty of metal to remove in the finish grinding, to remove the decarburization. Look at the tempering chart for this steel. 1050 to 1100 degrees is a good draw temperature.



This is the old standby. It is the best choice to make for good knife blades, if you want stain resistance steel that will hold a good edge. It is almost as popular as 440C and has exceptional wear resistance from the high carbon and chromium content.



My one complaint is that it is rather brittle. If the blade is used for only cutting, it cannot be bent or pried on, and as I said before, it is a good stain resistant steel.

We dip and coat this steel with brazing flux, or wrapped in Stainless steel foil to prevent decarburization. Tempering should be for 3-5 hours.



They have made most of the knives in the last thirty years from 440C. Most of the factory knives have a hardness of 52-55 RC. This low hardness has given 440C a bad reputation for not holding an edge, and being hard to sharpen.



The hardness at quenching is not too hard, a mere 59 Rc. When you temper the blade, it reduces the hardness even further. If you temper it at 225 degrees, you will retain most of the hardness, but it will be brittle. The edge will chip very easily. If you draw the temper so to remove the brittleness, the blade will not hold a good edge, and sharpening it also will be difficult.



However, for fishermen, people who carry small knives to open letters, clean their fingernails, etc., this steel will work well. If you build art knives or a knife for a person that puts in his collection, 440C is the best choice.

They developed 154 CM from 440C so you could have a steel that could be heat treated to a hardness of three to four points harder than 440C. There also is no sacrifice in toughness. I would have to rate it on wear and performance in the same category as F2 or M2, and I would recommend this steel as an all-around knife steel.

You may have some problem in finding suitable sizes for folding knives. Heat-treating 154 CM is similar to 440C. It should be soaked for about twenty minutes at 2000 degrees, and quench in oil or water. Unless you coat the blade good, or wrap it in a stainless steel wrap, you will get much decarburization.

For your first knives, I would recommend 01 tool steels. Working with it will be easy and give you excellent results.

HEAT TREATING

This is the part where you take a soft piece of metal, and turn it into a cutting tool. Heat-treating is not difficult unless you get into Stainless Steel or other high temperature tool steels. I will show you how to heat-treat tool steels such as 01.



The first step in the heat treatment of steel is the heating. The purpose of the heating is to form austenite and to dissolve carbon in the austenite. The solution of the carbon is necessary so in the second step of heat treatment. When the transformation of austenite takes place, the steel will develop the desired hardness.

You must remember that though a large amount of carbon is in the steel, it is not effective in developing hardness unless it is first dissolved in the austenite.

The hardness increases rapidly up to 60 Rc as the carbon increases to 0.40 to 0.70%, above about 0.70% carbon, the hardness remains practically constant. For maximum hardness in the steel, therefore, approximately 0.70% of carbon must be dissolved in the austenite. All the steels discussed here, except the chromium molybdenum hot work steels have enough carbon in the analysis to attain a hardness of 65 Rc.

Two other factors are involved in the heating of tool steels, besides the formation of austenite and the solution of carbides. These are grain coarsening and melting of the steel, but in tool steels, the grain size should be as small as possible.

Fine-grained hardened steel is inherently tougher than coarse-grained steel. Usually, there is little concern about coarse grain in tool steel because coarsening of the steel does not occur until the temperature is well above the usual austenitizing temperatures.



When we heat steel above this temperature, the grain assumes a definite size for that particular temperature, the coarseness increasing with an increase of temperature. Moreover, if the steel that we have heated above the critical point is cooled slowly, the coarseness of the grain corresponds to the coarseness at the maximum temperature. Therefore, the grain of annealed steel is coarser, the higher the temperature to which it is heated above the critical point.



Fire up the heat treat furnace if you have a gas furnace, or turn on the electric furnace.

NOTE - If you have a gas furnace light up a butane torch, and turn on the blower. Holding the torch over the opening, slowly open the gas valve, and there will be a poof as it lights.

M2 ROCKWELL HARDNESS



Do not open the valve too much when you do this. You want to see three to three inches of flame coming from the top of the furnace, no more or no less. This is a slightly rich flame, but is needed to help to keep the metal from decarbonizing.



If you have an electric furnace you will need to get some stainless steel foil, found in most knife makers catalogs. Do to the time the blades are in an electric furnace, if you do not wrap the blade in stainless foil it will decarbonize badly.

The blade has to be wrapped tightly in this foil.

With the gas furnace, turn down the air and gas until the temperature reaches 1000 degrees. Hang the knife by small hooks made from wire in the opening, and when it starts to get a dull red, then dip it in a non-scaling compound. Make sure it is completely coated good, it will melt and form a protective coating on the blade. Put the blades back in the furnace, and increase the air and fuel slightly and it should slowly go up to 1550 degrees.



To get a uniform temperature, raise the blade up toward the top of the furnace, and move the temperature sensor up to the top of the furnace. For you who have good color sight, you can use the color of the metal to arrive at the correct temperature.

I would strongly recommend that you use Tempilaq to see the correct temperature. Tempilaq can also be purchase from Brownells. It comes in just about any temperature you would want. With Tempilaq, you can do an accurate job of hardening without a temperature gauge. This is good if you are only doing a few.

752 degrees: Red heat, visible in the dark.

885 degrees: Red heat, visible in the twilight.

975 degrees: Red heat, visible in the daylight.

1077 degrees: Red heat, visible in the sunlight.



1292 degrees: Dark red.

1472 degrees: Dull cherry red.



1652 degrees: Cherry red.

1832 degrees: Bright cherry red.

2015 degrees: Orange red.

2192 degrees: Orange Yellow.

2372 degrees: Yellow white.

2552 degrees: White-welding heat.

2732 degrees: Brilliant white.

2912 degrees: Dazzling white, bluish white.



Have your quenching oil ready when the blades get to the right temperature (1500 to 1550 degrees). This oil can also be purchase from Brownells.

When the temperature is right, or the Tempilaq melts, raise the knife from the furnace and lower it straight into the oil. Make sure the blade is not swinging when it hits the oil, as that may cause it to warp. Once in the oil, gently agitate it to cool it thoroughly.

440C is very similar to 01 with the following two exceptions. (1) We bring 440C to a higher temperature. (2) We quench 440C in air rather than water.

We bring 440C to a temperature of 1850 to 1900 degrees. It is best to heat treat this steel in an electric furnace, because there can be slow heating, and very controlled temperatures.

Take a piece of stainless steel foil, large enough to wrap the blade up in. Wrap the blade so the blade will be airtight. This is important as the time and the temperature in the furnace will cause the steel to decarbonize rather fast. If you tried to heat treat stainless without some protective coating, you would have to grind several thousands off to get to reach the hardened steel.



If you have a temperature gauge that will go high enough, you can dip the blade in brazing flux. This is done after preheating the blade to 1000 degrees. Using this method, you can use the gas furnace. You have to be careful, as the temperature will go high enough to melt the steel. If you are skilled enough at reading colors, you can use this method to establish the correct temperature. However, this method can be hit or miss.

440 C STAINLESS STEEL HEAT TREAT PROCEDURE

Wrap the blades in tool wrap; double crimp all edges of the foil being careful to avoid having even a pinhole in the foil. You may double wrap for extra assurance of locking out all oxygen. You may wrap the blades with 5-6 stacked side by side or individually wrap and place them in a furnace rack. This rack will hold the blades in an upright position for reducing warping.

2. After placing the blades in the furnace heat to 1850°F., then after reaching 1850°F, start timing the soak time of 20-25 minutes.

3. After the soak time has elapsed, carefully slide the blades on a steel grate or heavy wire mesh for room temperature cooling. (This is the air quench) Place aside for cooling. The grate or wire mash will allow air to circulate under the blades and around them for uniform quenching.

4. While the blades are cooling, leave the furnace door open and allow it to come down to 220° F. Sometimes the blades will be cooled before the furnace comes down. Then, keep the blades warm (place near the furnace door) or you may use the kitchen oven for drawing. It is important on all grades that they do not cool much below the 125°F temperature before drawing. (There are furnaces for tempering or drawing also available).



5. After placing the blades in the 220° F. temperature, they should remain at this heat for two hours.

6. Pull the blades out for cooling and place them back at 200° F again for two hours,

7. Check hardness. You should have approx. 59 Rc. For extra stability, you may freeze the blades in dry ice for one hour. This will also increase the hardness a point or two.

Note: All the above procedure is based on our own experience, realizing that other people use some of their own trial-error. The equipment must be accurate and periodically the calibration checked.

There are no shortcuts for proper heat-treating, always exercise care to insure a good quality job.

When the blade has reached the correct temperature, remove it from the oven. Remove it from the foil and hold it in front of a fan to cool.

D2 is heat-treated the same way as 440C, except for the temperature. We bring up D2 to a temperature of 1750 to 1850 degrees. Then it is quench in air. You must to remove the foil as fast as possible. A good stream of air is important to achieve good hardening.

The choice of using 01, D2, or 440C is mostly personal. If you want a knife for carrying daily, and you do not want to have to worry about having to take care of it, then 440C is a good choice. Most knife makers like 440 also because it polishes out easily. Its main draw back is that it does not sharpen easily, or holds an edge.

D2 is a very good material for knives. It has one drawback though, and that it is rather brittle, but all these steels are easy to heat-treat and work

AISI D-2 HEAT TREATING PROCEDURE

1. Wrap blades in tool wrap. Double crimp all the folded edges being careful to avoid having even a pinhole in the fail. The blades may be wrapped individually or stacked side by side (stack no more than five or six per pack for ease of handling).

If we wrap them individually, you may consider placing them in our optional furnace rack that will hold the blades in an upright position for reducing warping.

2. After placing the blades in the furnace heat to 1850°F. After reaching 1850°F immediately start timing the soak time of 15-20-minutes.

3. After the soak time has elapsed, carefully slide out the package on a steel grate or wire mesh for cooling in room temperature. (This is known as the air quenches).

4. While the blades are cooling, allow the furnace to cool down to 950°F.

5. When the package has cooled enough for handling, remove the foil. The blades should be warm (approx. 125°F). At this time place, them back in the furnace at the 950°F temperature. After the blades have reached this temperature, allow them to remain (draw) for two hours.

6. Remove the blades for cooling down to room temperature and place them back in the furnace at 900°F again for two hours. (This is a double temper we suggest for D-2.)

7. After removing and cooled then check hardness. You should have 58/60 Rc. For extra stability and 1 2 points higher hardness, you may pack the blades in dry ice for one hour.

This is an oil-hardening grade of steel that will require oil quenching. The oil should be warm, thin quenching oil that contains a safe flash point. Olive oil has been used as a substitute. There should be a gallon of oil for each pound of steel. For warming the oil before quenching, you may heat a piece of steal and drop in the oil.

1. Wrap the blades in stainless tool wrap and leave an extra two inches on each end of the package. (This will be for handling purposes going into the quench as described below.) We suggest a double wrap for this grade. The edges of the foil should be double crimped being careful to avoid having even a pinhole in the wrap.

2. Place in the furnace and beat to 1900°F, after reaching this temperature immediately start timing the soak time of 25-30 minutes.

3. After the soak time has elapsed, very quickly and carefully pull the package out with tongs, place over the quench tank and snip the end of the package allowing the blades to drop in the oil. You should have a wire basket in the oil-quenching tank for raising and lowering the blades rather than have them lie still at the bottom. Gases are released while quenching and would form a trap around the steel unless you keep them moving for a minute or so.

IMPORTANT it is very important that the blades enter the oil or quenching media as quickly as possible after leaving the furnace. Full hardness would not be reached if we have not followed this step.

4. After we quench the blades down to near room temperature, preferably around 125°F, they must reenter the furnace at 300°F. After they reach 300° F, allow them to remain for two hours.

5. Remove the blades and place them aside for room temperature cooling.

6. After they have cooled to room temperatures place them back in the furnace at 275°F for two hours. Remove and check the hardness and you should have approximately 60 Rc.

7. For extra stability and a point higher hardness, you may pack the blades in dry ice for one hour.

Now comes the most important part of heat-treating process and that is of tempering of the metal. We can temper Harden steel or make it softer and less brittle by reheating it to a predetermined temperature, this depends upon the nature of the steel, and its intended use. In tempering, I let the oven cool down to the temperature that I need to draw the temper.

When the tempering is done by the color method, the colors gauge the temper formed on the surface of the polished metal as the heat increases. The color method of gauging temperatures is not dependable, as the color is affected, to some extent, by the composition of the metal.

Tempilaq is a compound that you can buy, in any temperature range, to put on the metal. When it melts, you have the metal at the proper temperature. Having a temperature gauge to get the correct temperature is better.

After you have worked with a certain type of steel for a while, you can probably judge the correct temperature by the color. Polishing the metal to a bright finish is best so we can see the color clearly.

430 degrees: Very pale yellow, extra file hard, dies, milling cutters, cut off tools.

440 degrees: Light Yellow, file hard, reamers, thread chasers, fly cutters, and hollow mills.

450 degrees: Pale straw yellow, profile cutters for milling machines, rolling dies, knurling tools.

460 degrees: Straw yellow, knife hard, swages.

470 degrees: Deep straw yellow.

480 degrees: Dark yellow, cutting dies.

490 degrees: Yellow brown, extra hard, taps, dies.

500 degrees: Brown yellow, thread dies for general work.

510 degrees: Spotted red brown.

520 degrees: Brown purple, hard.

530 degrees: Light purple.

540 degrees: Light purple.

550 degrees: Dark purple.

560 degrees: Full purple.

570 degrees: Dark blue, half-hard.

620 degrees: Blue gray, spring temper.

700 degrees: Very light blue gray, spring temper.

Using 01 for the blade stock, you can draw back the spine (back of the blade) to a temper of 700 degrees. This will make the blade tough, but will leave the cutting edge hard. D2 & 440C you cannot do this. This comes in handy if you are making thin blade folders.

After hardening, let the furnace cool down to the temperature that you want to temper the blades. Put them in the furnace and let the whole thing cool down.

THE GAS FORGING & HEAT TREAT FURNACE

A gas furnace for heating materials in your shop is one of the handiest pieces of equipment that you can own. With a gas furnace, you can get the necessary heat so you can heat, shape and forge all type of metal objects.

My gas furnace has been indispensable in my small shop for years. I could make small metal parts and then heat-treat or case hardened them with this furnace. You can change this furnace to about any shape and size that you need moreover makes an excellent blacksmith furnace.



FURNACE AND GAS VALVE

It will not get hot enough to weld metal but you can do all of the forging with it. I will show you through drawings how to make a top loading and a front-loading furnace. Remember if you need a special size, changing the dimensions for any size that you need will be simple.

If you go to a larger furnace, you may need to run an additional fuel/air pipe to get the increased heat. By using pure oxygen on the air intake of the blower, you can increase the temperature somewhat.

A-Gas/Air outlet; B-Furnace opening; C- Side view; D-Opening for temperature sensor; E-Blower; F-Gas intake; G-Heat sensor pipe; H-Heat sensor opening.

We can make the gas furnace in about a day depending on the size, and usually everything that you will need can be found locally. I will cover in this article how to make a top loading gas furnace, and depending on the size, by scrounging you can probably make one for well under \$100.00.

The furnace for the top loader is easy to make. You will need eight firebricks to make this furnace depending on the size. When completed, you will have a furnace with an inside measurement of about four 2 by three by eight inches. This size will handle most any small jobs that you may want to do and it is an excellent furnace for heat-treating knife blades.



COMPLETED HEATTREAT FURNACE

The first item you will need is some mortar cement that most hardware stores carries for wood burning stoves. Another source is a business that sells fireplaces and wood burning stoves. You will need eight standard size fire bricks (9 X 4 1/2 X 2 1/2 inches) to build this furnace, and the above businesses should carry these.

You will need several pieces of threaded one-inch iron pipe and a two-inch valve that will be used to shut down the air/gas mixer. You also will need some two-inch pipe, also a reducer to go from two inches to a one-inch pipe. The drawings are self-explanatory on hooking up all the plumbing so there should not be any problem there.

LIST OF MATERIALS

- 1. A high volume blower.
- 2. 2 inch to 1-inch pipe reducer or hose.
- 3. A 2-inch valve.

4. A inch needle valve for controlling gas flow and a high-pressure hose for connecting to a Propane bottle.

5. Several pieces of one and two-inch pipe, depending on your setup. Wait until you get everything made and set up before buying these.

- 6. Brick mortar.
- 7. Fire Brick, quantity will vary according to the size of your furnace.
- 8. A high temperature gauge (2000 degrees).
- 9. A temperature sensor.
- 10. A small pipe that the sensor will fit in.
- 11.3 c inch pipe for gas valve and mixer.

12. Propane tank.

13. A 4-inch round flat metal for mounting on a blower to regulate airflow.

14. A light dimmer switch for regulating blower speed.

15. Electrical wires as needed.

16. A bottle of Tempilaq for the temperatures needed, this will eliminate the need for number 8 and 9 of the above.



A high volume blower such as is found on vacuum cleaner, is necessary for the high volume airflow. This can be located, and bought used from a vacuum cleaner business, or you might even have an old one lying around in your garage.

You should also have a metal table with a metal plate on top of it the size of your furnace to build the furnace on and to help protect the table from the heat. Once you have your bricks and mortar, you can start building this furnace. If you have a well-ventilated building or garage you can operate this furnace there but be careful that you have no combustible materials overhead.

I do want to warn you that this furnace produces lots of heat, so it should not be placed near any type of combustibility material. Keep plenty of space between it and the wall. The fuel that you will use is propane and the propane bottle as the ones hat is found on barbecues can be used to operate your furnace.

BUILDING YOUR FURNACE

Set up your metal table with the metal plate on it, at the location you plan to build the furnace. Start with bricks (See Figure 1 & 2) for the bottom and mortar the firebricks with the cement that you bought. You place two of the bricks flat, side by side on the metal table. We should mortar these bricks together when you set them on the table. Two more bricks are then placed on the first two that are lying flat. These two and the others are mortared together on their edge. Let it set over night before doing any additional work on it.

The next thing you must get is a cement drill that is slightly larger than the pipe that you are using from your hardware store. With this drill, you will drill one hole 3 inch above the base in the center of the

furnace. This is where we will insert the one-inch pipe from the blower. There are many ways of hooking up the plumbing, so you will need to buy the correct length pipe after getting everything assembled.

The furnace that I am and describing is a top-loading furnace, which means that we hang the parts from the top using stainless steel wire. If you decide to build a front-loading furnace, you will need a three or five-inch opening depending on the size in the top of the furnace for the gas to escape.

When you hook the blower to the two-inch pipe, you will need a pipe reducer or a flexible hose and two hose clamps to attach the hose to the pipes. The rest of the connections can be done as shown in the drawings. We mount a round adjustable flap on the intake side of the blower to regulate how much air that it will produce.

THE TEMPERATURE GAUGE

A high temperature gauge can be purchase from an industrial supply dealer if you want to control the temperature precisely. You can also buy from Gunsmith suppliers a temperature indicator called Tempilaq. It comes in many temperature ranges so you can buy a bottle of this for the temperature that you need.

To use Tempilaq, paint some on the metal and let it dry. When you put in the furnace watch it closely as the temperature rises. When the temperature of the metal reaches the temperature of the Tempilaq, it will melt the Tempilaq. At this point the part is ready to come out of the furnace or you can reduce the air/gas mixture to maintain this temperature.

If you want a high temperature gauge, we can buy this from an industrial supply business. You will need to have one at will reach 2000 degrees so there will be a safety margin for the gauge. You will also need a thermocouple that will be attached to the gauge, and the head of the thermocouple will be inside the furnace.

Get a large enough cement drill to drill a hole through the fire brick about two inches from the top if you have a top-loading furnace. The thermocouple will fit inside a short length of iron pipe that is large enough on the ID to allow the thermocouple to fit. We then mortar this pipe in place in the furnace.

By following the above instructions and the drawings that we include, you can build you a furnace that will have many uses. If you want to build a front-loading furnace that is larger than the one that I am describing. You will need to support the bricks as shown in the drawing on the front-loading furnace.

LARGER FURNACES

What I do on larger furnaces for the additional support and strength of the roof bricks is to buy a long length of 3-inch rod from the hardware store. I cut out the necessary number of pieces four inches long to provide the support for the firebrick on the top of the furnace. I use a 3 cement drill to drill the holes in the end of the bricks.

I then insert the 3-inch rod into the hole that has mortar inside it, and then I will take the brick with the corresponding hole, apply mortar to it and put the two together. This is done on the flat floor, and then I let it set up over night.

While this is setting up, you can start cementing and setting the bottom of the furnace bricks. Once

they are in place, start cementing the sides and the ends of the furnace. Be careful when you set the sides and the ends in place so that the tops of the bricks are even.

The next day, mix up some more mortar and put the top bricks in place, being very careful that they all fit together snugly. After you get the top mortared and put in place, let the furnace dry over night.

Now you need to drill the vent hole in the top part of the furnace. Now drill the three or five-inch hole (depending on the size of the furnace) in the top of the furnace. I have found that if you take an 3-inch cement drill you can make a circle in the bricks. To do this, mark a circle out on top of the bricks in the location where you want the hole.

With the 3-inch cement drill and electric drill, start drilling the holes all the way through the bricks, about c inch from the edge of the last hole. When you get all the holes drilled, you take a thin chisel and break the thin edges between the drilled holes.

Once they are broke loose, we can remove the center plug. I have even used the cement drill on the angle to cut those connecting ridges along with chiseling.

After you get the gas vent done, you will need to get a cement drill slightly larger than the blower pipes. We will drill the blower pipe hole in the sides of the furnace so that the bottom of the pipe is about 2 inch above the bottom. You have to watch where you put these pipes so that they will provide equal heat on the front and back and the center of the furnace.

When you finish drilling these holes, take two, one-inch (depending on the size) pipes that should be about six inches long, and place them in the holes you have drilled. They should extend through the holes on the inside of the furnace about 2 inch.

Once you have those pipes in place, you can take measurements and by the necessary elbows and pipes to finish the job. This is why I said previously that you should not buy the pipe and fittings until you have finished the furnace body. The gas/air pipes that you have placed in the holes in the side of the furnace should be mortared in place.

Usually, we will make this furnace to the size for what type of work for which we intend it to be used. After you have connected all the plumbing, you will need to connect the blower to the unit. I have found that an old radiator hose makes an excellent hose for connecting the blower pipes.

We can buy the air flap that you put on your intake opening on the blower at your hardware store. It is a cover plate for electrical boxes the metal type. You drill a hole in it at the top the size of the screw you are going to use. Next, holding it in place on the blower drill, tap the hole in the blower housing. There are two ways to attach the flap; one is to just screw the flap in place. The second way is to run a screw through the tapped hole and use a wing nut and washer to hold the flap in place.

About all that is left, to do is drill your hole for the heat sensors if you plan to use one. If you have a welder, you can finish the furnace out by enclosing it in metal. All you need to do is cut some c and metal plate to the size that you need for the sides, ends, and top. They can all be welded together so that the furnace will look neater. You can even make a door for the front of the furnace, which is handy for annealing metal. If you make a door for the front, be sure to use firebrick that will fit the opening of the furnace. The firebricks are attached to the metal door with long screws.

When lighting the furnace the first time be sure to shut the airflow way down. Leave the gas shut off until you have the air adjusted, and then slowly turn on the gas, while holding a lit Butane torch over

the opening of the furnace. Once lit, more than likely there will be quite a bit of flame coming from the opening. If this happens, slowly increase the airflow until the furnace roars and produces a blue flame.

Once you have the flame adjusted, you probably will not need to adjust it again. You can also use a room dimmer switch to slow and adjust the blower. The flame from this furnace is very hot and will heat steel to a yellow heat necessary for forging.

The plumbing will be about the same for any type of furnace you will build. The pipe sizes may be larger on the bigger furnaces. If you have any doubt on the pipe sizes, go to the next larger size, as the fuel/air mixtures can be fine tuned for the larger sizes.

GETTING STARTED

First, decide what kind of knife you want to build, or use a factory knife pattern to make your knife. First, if you want to use your own design you will need to draw the knife design to actual size. When you design a folder, you always start with the blade first, and sketch this out on thin cardboard. Estimate the location of the pivot hole (refer to the drawing) and use a compass to draw a small circle around this point. The circle should have about a half-inch a 1/4-inch radius.

After making a copy of it, take a piece of thin aluminum, brass, or 1/16-inch tool steel sheet, the tool steel is better to use for making the templates as it last longer. When you get the parts cut out and fitted, you can harden it. Get some rubber cement and glue the pattern to the metal. When dry go to the band saw and very carefully cut out each pattern. Take a file and go over it to smooth out the band saw marks.



TEMPLATES & FINISHED PARTS

Carefully, center punch where the holes are and drill them. The main hinge pinhole is c inch, and the others are 3/32 inch. Slightly countersink these holes to remove any burrs. If you are working with a look back, take the blade template, and with a narrow file true up the locking notch. The notch should have a very slight angle at the back so the lock will keep tight through use. If we cut the notch square, there will be slack in it when used for a while.

Take the lock, and file the front square, (the part that goes in the blade notch). Carefully hold the lock against the front of the lock on the blade and check the angle of lock and blade. The blade and lock should blend in at the same angle.

The blade should not stick up or point down. When you have this angle right, very carefully fit the back of the lock so it fits exactly in the lock of the blade. When the blade and the lock fit right, the top of the blade and the lock should be flush.



USING FACTORY KNIFEAS PATTERN

The spring retainer is cut out and filed like the other parts. The groove where the spring goes needs to be filed to a width of 3/32 inch; this is the usual size for most springs, unless you go into a bigger knife.

After getting all the patterns filed out, put the pattern back on the template. Now take a center punch and mark the templates where we should drill the hole. Drill all the holes 3/32-inch except the larger blades. These should be drilled c inch.

The template for the liner is done the same. However, the only hole that you use is the hinge hole. We drill the other holes as you fit the parts.

The exception to this rule is when you are making spring back knives. You drill all the holes, including the liner.

There are two different ways to do this. 1- Use the heat-treating furnace, 2-use a torch. If you use a torch, heat both sides evenly. When the template gets to a cherry red, quench straight down into the quenching oil.

Going straight into the oil is very important. If you quench on an angle, the templates will warp. After hardening the templates, polish one side good. Take a butane torch and slowly heat the part. When you start to see some color in the metal be careful, as you want to get the color a straw color. Let it cool and the template is ready to cool.



Take a piece of tool steel the thickness that you want the blade and lock made from. Usually knives with blades less than two 2 inches you use 3/32 inch. Blades more than two 2 inches long use c inch stock.



Wipe any grease or oil off the tool steel. Give it a good coating of layout fluid, or Dykem. We put this on so you can see the scribe mark that you use to mark out the pattern. Lay the blade template on the tool steel stock. Hold it down good, or use a clamp so it does not move. Take a very sharp scribe or a heavy needle and mark around the template. Repeat the process with the other parts. You can use brass or tool steel for the handle template.

Once we mark out the parts, they are ready to cut out on the band saw. Make sure that the band saw is running at a slow speed. Do not try to cut the steel at wood cutting speeds. The teeth of the band saw blade would burn off. Carefully follow the lines that we marked on the tool steel.



Cut out each piece for the knife, leaving a .032 or so on the outside edge of all the pieces that you cut. Leave at least 3/32 extra in the kick area, which will be fitted later. This will insure that all the parts will be flush when we grind down the outside edge.



Take the template for the blade, and center it on the blade blank. Use a small C clamp and clamp the template to the blank. Go to the drill press and get the correct size drill bit. Drill through the hole in the template, and through the blank, and put a line up pin, or the drill bit in the hole you just drilled.

NOTE-After getting the fitting done, use a drill bit that is 3-4 thousands larger than the pin you will put the knife together with. This insures that the blade will not bind in the hole in the blade.

Clamp the blade and template in the vise. With a flat file, carefully file the blade blank down to the template. The only part of the blade that needs to be fitted is around the pin, and on a lock back, the notch, and the radius behind the pin. The area of the kick, cutting edge, etc. does not need to be taken down now.


DESIGNING THE HANDLE TO FIT BLADE

The blade lock (if making a lock back, spring if making a spring back) is carefully centered to the lock template. Then we clamp it, and drill the pin hole, once the pinhole is drilled, stick a pin in the hole to keep everything lined up. Clamp the lock and template in the vise, and carefully file the lock down to the template. Remember that we harden the template, and it will take the edge off the file. Just file the blank down to where the file just hits the template.



The final fitting is done with the blade blank. Set the lock in the blade blank lock notch, and see how well it fits but more than likely you will take more off the back of the notch. File, fit, and check until you have it most of the way down, but not all the way.

Clamp the blade blank in the vise, set the lock in the notch, then take a small hammer, and seat the lock the rest of the way. When you seat the lock, make sure that the lock stays straight with the blade. Seating the lock in this way assures you that you have a good fit. We should seat the lock and blade firmly together now, and for now leave them together.

Usually you will use 1/32 material for the liner. Lay the handle template on the stock, mark it out, and cut it. When done clamp the pieces together, and file or sand them all to the same size.

The bolster is next. For most lock backs, and larger spring backs, make the front bolster 1 long. This adds strength to the knife. On smaller knives, we cut the bolster lengths for both ends e inch long. If you are making a larger knife, mark a line all the way across a piece of c inch thick nickel silver, or brass. Take the liner where the bolster goes and mark the width on the sheet of nickel silver or brass.

Once the width is set, band saw the bolster stock out. Once they are all cut, go to the table sander and sand one side flat. We will solder this side to the liner.

Set the round disk sander table (on the belt sander), to 45 degrees. This angle will lock the handle material to the bolster.

Turn on the sander and carefully press the edge of the bolster against the sander disk. This will cut the 45-degree angle. Have a pan of water handy, as the bolster gets hot fast. Grind for five to ten seconds, and dip the part. Keep doing this until the edge becomes sharp. Finish the rest of the bolsters and we will sweat them to the liner. The instructions here are for a bolster on one end.



MARKING OUT PATTERN

You will need to get some powdered plumber solder from your local plumbing shop. This solder has the flux in it already, which makes it very simple to use. I have used other methods of applying solder, but this is the best and the quickest.

Take a ruler and holding the edge on the topside of the liner, mark one inch. If you have a thin metal ruler, hold it so it measures one inch, and being sure it is flush with the top of the liner. Let me explain further. Holding the liner flat, and lay the ruler on it, flushing the edge of the ruler, to the top edge of the liner. Take a flat piece of cinch brass, lay it on the liner, flush it against the end of the ruler, and clamp it in this position.



LOCATION OF PIN HOLE IN BLADE

Apply a very thin layer of powdered solder over the entire surface where the bolster will be. Take one of the bolsters, and lay it on the liner with the 45-degree angle flush against the piece of brass. Clamp this in place. Remove the clamp that holds the brass on the liner, and put the piece of brass

back for later use.



SAWING OUT KNIFE PARTS

Clamp the liner in the vise, and get a butane torch and heat the bolster until the solder melts, and the flux turns a dark brown. Turn off the torch, and quench the soldered liner/bolster in a pan of water. This removes most of the solder flux.

Repeat the operation on the other liner, making sure that we line both bolsters up the same. Look for any puddles of solder on the 45-degree angle. If you do see these, scrape or file this off, as it will interfere with the fitting of the handle.

If you are using rear bolsters, now is the time to attach them. On these, you will fit the handle material first. To do this, mark and cut out two pieces of Micarta or Pakawood. Have enough material around the sides so it will not be too hard to fit on the first knife.



LOCK FITTED TO BLADE

Go to the belt sander, and on the sanding disk, grind a 45-degree angle on the bolster material. Flatten the bottom side of this material on the belt sander. We need this to assure that the material will lie flat on the liner.

Set the handle in place, against the 45-degree angle on the bolster. It should rest flush against the bolster, with no gaps. If everything is OK, clamp the handle in place on the liner. Turn the handle over so the underside will be up. Take one bolster that you have for the rear, and set it in place on the bottom side of the liner. Holding it in place, take a pencil and mark a dot on the handle material.

This should be on each side, and on the undercut of the bolster. To explain a little further, you take the handle material from the liner. Take a small ruler, holding it in line with the two dots, and draw a straight line from one dot to the other. The back end of this material is then band sawed off. Take this piece to the Disk sander and cut a 45-degree angle on the end that you cut off.

If you did everything right, you can probably clamp the handle material on the liner, and check for fit. With the handle materials in place, set the rear bolster in place, and check how much it is sticking over the liner. It should not be sticking more than 1/16 inch.

If it is, take off a little more from the end of the handle. Try it again, and if it is OK, you can solder the rear bolster in place.



ADDING TENSION TO A SPRING

Put some plumbing solder on the liner, where the bolster will go. Carefully hold the bolster in place, and clamp it. Remove the handle from the liner now. Clamp the liner in a vise, and with the butane torch, heat the bolster until the solder melts. Remove from the vise and quench in water.

You can now use the handle as a pattern and cut out the handle for the other side. Make it the same as you did the first one.

With the bolsters soldered in place, drill two or three 0.053 holes in the liner. Through these holes,

you will attach the handle material. Mark a spot about 2 inch from the 45-degree angle on the bolster. We should center this on the liner. Center punch, and drill the hole. Now measures about 1 inch from the end of the liner, center, and drill another hole. If you use a rear bolster, measure 2 inch from the 45-degree angle.

With the handle clamped in place, turn over the liner, and drill through the holes, and through the handle. These holes will be counter sunk on both sides a little. Counter sinks these just enough so the pins will grip well.

Take a piece of .050 nickel silver wire; insert it through one of the holes. Clip it off flush, turn the liner over, and lay the liner on the vise. With a little ball peen hammer, very carefully roll the edges of the pin just enough so it will fit the counter sink.

Turn over the liner and on the handle side and repeat the process. If you have more than .015 sticking out, take a little more off, so it barely sticks up. The reason for this is that if there is too much pin and peening it down will cause it to swell. It will then split the handle. Repeat the process on the other holes. When the handle is fitted to the liner/bolster, you are ready to grind the blades.

CUTTING OUT THE BLADE

The steel cutting band saw blade can only cut annealed steel, so the first rule is that the steel must be annealed. If you buy from a knife supplier, the steel will most likely be in the annealed state when you get it. Some knife makers use a torch, hacksaw, etc. but all these methods are slower and do not produce good results.

To anneal saw blade steel, or any low alloy carbon steels, heat it in a furnace to about 1200° F. This is a dull, faint red, and cool slowly for three hours by turning the furnace off with the steel still inside. The other way is to heat the steel and place it in powdered lime to hold the heat in the steel, allowing it to cool very slowly.



SAWINGOUTKNIFEPARTS

The metal cutting blade must be of fine quality and with teeth small enough so that three of the teeth are on the work piece always. The saw needs to run at the right speed, which means, if it is cutting at wood cutting speed we should install a speed reducer on the band saw.

The cutting speed for steel is very slow, or around 80 FPM for most steel cutting blades. I could not get a speed reducer and had to modify my saw with a double set of large and small pulleys to make it run slowly enough so that it did not burn the teeth off the blade. Once the knife is cut out, carefully grind off the saw mark from the edges, and true up the blank to its final shape on the outside.

If you haven't already done it, now is the time to drill all the holes in the tang. When drilling the tang to receive pins or rivets, you naturally want to use high-speed bits although the metal is relatively soft. Also lubricate the drill hole with cutting or light machine oil as you drill.

GRINDING THE BLADES

The convex bevel is best for cutting materials that is heavy and hard, where a large amount of force is used, such as bone or wood. This is because the cutting edge is backed by thick, heavy steel that is unlikely to break.

The concave bevel is used for softer materials, such as vegetables or meat where the blade cuts deeply, producing little friction. They also know it as a hollow grind because the side of the knife is hollowed out along the edge. It cuts more easily, but is not as strong. As the cutting edge wears back after many subsequent sharpening, the convex blade becomes thicker and thicker. They also call it the axe grind and through use becomes harder and more difficult to sharpen, while the concave blade stays at the same thickness for many, many sharpening.



CROSS-SECTON SHAPES OF KNIFE BLADES

The straight bevel or simple wedge is half way between the other two shapes. The intended use of the knife determines the shape and thickness of the cutting edge and the way in which we grind it. I usually start with a hollow grind, and if the knife will have a convex bevel, or a straight bevel, then I do not take the hollow grind shallower. I hollow grind most knives and do about 85 percent of the stock removal with the heavy thirty-six grits on the knife grinder.

When you start grinding the blade, taking long even passes along the full length of the blade. Do not stop in anyone place or it will become deeper in that spot. If this happens, feel the evenness of your work so you can lighten up the pressure when you come to a depression or hold longer when you come to a high spot. You will have more leverage along the edge nearest the handle; we can take this area down too thin before you realize it. As you are about halfway through grinding, concentrate on keeping the edge even.

Grind out a groove along the blade matching to the arc of your wheel. Tilt the blade backward slightly on each pass, and gradually remove more stock toward the edge, producing a straight line from the deepest point of the hollow grind to the cutting edge.

Keep repeating this process until you are about half way done on one side, and then turn the blade around and continue on the other side.

Do not take too much material off in anyone place. When you have both sides approximately half ground, be careful about keeping things even and about the same distance up on each side of the blade. Dip the blade in water every so often, running your fingers up and down the edge feeling for thick and thin spots. Keep grinding until the blade it is about 85 percent complete.



If you are grinding a thin blade, such as a trapper knife, you probably cannot grind as much before heat-treating. If we grind the blade too thin before heat-treating, it will probably warp. Now, heat treat the blade, and regrind it carefully to its desired thickness. The regrinding is done on a belt grinder, using a new, coarse belt.

If you want a good smooth job, grind the blade at least three or four more times with the belt grinder, each time with a progressively finer grit belt.

Grinding the tip of the blade, where the edge tapers off, is next, and it is difficult, requiring much practice. This is especially true getting the hollow grind to go clear to the tip. When finish grinding you will have a thin tip, but not so thin as to be weak. The line of the hollow grind should be mostly parallel with the edge, but perhaps tapering slightly toward the edge near the tip.

On grinding this bevel, I run a series of shallow cuts from the edge up to the backbone of the blade with the knife grinder. Usually, when I finish the blade I usually use a flat belt sander (8 X 48) for this type of grinding.

I believe this is the easiest type of blade to make. It is used for heavier knives such as combat knives, or hatchets. There is little danger of accidentally grinding the edge too thin and ruining the knife. You make the deepest cuts along the edge, where they are easily seen and felt. Grind the heaviest along the edge, and then tapering it according to the design of the knife.



HOLLOW GRIND BLADE

If the blade is too thin when it is heat treated, it may crack or curl up like a potato chip during the process. If it is too thick when hardened, you will spend more time grinding the steel to its desired thinness. Hardened steel more difficult to grind, but it must be kept cool during the regrinding process.

We would damage a very thin knife, like a trapper blade, if we ground it more than 75 percent toward completion.

Normally, grind a blade as near to 90 percent of completion as you can, and use the 10 percent of the stock for removal in the final grinding and polishing steps. If the knife has a very thin ground edge, in relation to the thickness of the back of the blade, remove a smaller amount of stock before heat-treating.

Generally, I grind the blade to about .024 to .028 in thickness at 3 inch from the cutting edge after they have been heat treated and reground. I like blades with a fine grind, for outdoor use, with exception of heavy hunting and survival type knives.



If you have a Wilton grinder, get it set up with the eight-inch drum for grinding. The Wilton also has an attachment that has a flat surface for the blades to set against. This needs to be set up on the grinder. What this does is to give you added support when rough grinding.



FLAT GRINDING KNIFE ON BELT SANDER

Get a pair of Vise Grips and clamp it on tight to the rear of blade blank. This wants to be in front of the hinge pinhole.

Use a 36-grit belt for rough grinding the blank. You will need to scribe a line on the blank, following the curve of the blade. By doing this, you can grind both sides the same. After we rough grind the blades, and heat-treated you will need to scribe another line for the finish grinding.

Turn on the grinder and center the belt. Whatever you do, **WEAR SOME TYPE OF PROTECTIVE EYE SHIELD.** The belt is moving at a very high rate of speed, and if it breaks, it could cause serious harm.

With the blade being held in the vise grips, and the back of the blade against the support, make a light pass on the blade. The cutting edge of the blade will be up. Start from the back of the blade next to the kick, and bring the blade along evenly against the wheel. For now, do not try to bring the

tip of the blade to a cutting edge. All of this will be done later.

You should experiment on the angle of the blade. You want both sides when completed to come to the center of the blank on the cutting edge. Make several passes along the side of the blade, while you get the feel of the grinding. After each pass look at the contour, and try to keep it even. With a little practice, you will be able to rough grind a blade in 3-4 minutes. Remember to do one side and then the other. This will help to keep every thing even.

Let me explain a little further. When I say to the center of the cutting edge, I mean leave about 0.040 on the cutting edge, and we should center this. This is how much stock to be left for heat-treating. This assures you a little extra stock in case the blade warps. More on this later.

Do not worry how hot the blank gets during grinding, as long as it does not get cherry red. Carefully grind both sides down so they will be even. Try to keep the hollow grind fitting the wheel. This is a little hard to do holding the blade in vise grips. Just remember that rough grinding is what it means, taking off excessive metal. If you grind the blade too thin there is a very good chance it will warp. The cutting edge will probably look like a washboard.

If the hollow grind is a little uneven, it can be straightened up when you finish grind the blade. On the scribe marks, leave them about a of the way from the top of the blade.

When you have the blade rough ground, and completed, it is time to stamp the nail notch in the blade. Yes, I said stamp the nail notch in.

This is very easy to do. Get a tool bit 3/4 inch square; the kind used in machine shops for turning steel. Take a factory knife that has a nail notch in it for a pattern. Grind the end of the cutter bit down to match the shape of the notch in the factory blade. Do not worry if the factory notch is a little wider. You can walk this stamp to make the notch longer if you want.

When you get it almost finish, turn it end for end. If there is a sharp or square edge on the end that will be struck with the hammer, round it off, as tool steel is very hard, and may shatter and throw out steel splinters.

SIDE VIEW 5/8" X 5/8" HIGH SPEED CUTTER BIT TOP VIEW

NAIL NICK STAMPER

Use a piece of c inch flat cold roll steel or equivalent to check to see if you have it ground right. Set the plate on an anvil, or other hard surface, hold the stamp in place. With a large hammer, give the

stamp a good smack. You should repeat this two or three times to get the proper depth.

NOTE C some steel such as stainless steel may split if we make the notch too close to the top. I would suggest heating the back of the blade to a dull red before stamping. Go easy with stainless.

I would suggest leaving at least 1/16-inch clearance from the back of the blade to the notch. If you get a little more, you can always grind it off later.

After stamping the nail notch, be sure to check to be sure the blade is still straight. More than likely the blade will be slightly bent from the swaging operation. Lay the blade on the anvil, and lap it lightly to straighten ft. Check it with a straight edge for straightness.

The next thing that needs to be done is to stamp your name, a logo, and a date, serial Number on the shank of the blade. Stamp it deep, as sometimes during heat treating the blade will warp slightly. This can be straightened out also by tapping it out on the anvil.

Check over everything to be sure you have not missed anything, and if everything is OK, you can now heat-treat the blade. Make sure that you have the springs, locks, etc. cut out and the proper size holes drilled.

FINISH GRINDING OF THE BLADE

Now that the blade is heat treated, you can do the finish grinding. You will need to flatten the blank on the belt sander.

When, I flatten out the blade; I will finish out the sides completely. I start with 36 grit on the flat belt sander, to flatten the blade. Then I use 180 grit to remove the grind marks, and finish with 240 grit.

When, I flat grind the blade, I make sure that the topside of the blade where the lock area is .004 - .005 thousands thicker than the kick area. The reason for this is that you need this clearance so the knife will close easily. If you leave it flat, it will bind in the handle.

For the final finishing, I use a worn out 240-grit belt; I then coat the belt with white buffing compound. I can then finish the blade to a high finish.

Make sure that all the grind marks are out of the blade, or they will show up when the knife is finished. This is important so you can mark the scribe lines on the blank for grinding. To do this, clean up the blade so all the scale is removed. This is done with a wire brush; on a grinder, buffer, or drill press but it needs to be cleaned up enough so that Dykem will stick.

Once the Dykem has been applied and it is dry, you can mark the grind marks. We should mark the grind marks very carefully. These lines will show you how far to finish grind the blade. Several suppliers in the back of this book carry special tools to mark the blade. If you have a good eye, you can grind the blade even without using the scribe lines.

I usually start using 36 grit. This will true up the blade if there is any warping. You can probably grind the blade close to the finish size. We should grind the cutting edge of the blade now to .020 - .025. All the time that I am grinding the blade I hold it with my fingers. I do not hold the blade with any tool, such as vise grips.

Why don't you hold the blade with Vise Grips? When I am holding the blade with my fingers, I can feel the heat build in the blade. When it gets hot, I dip the blade in a water container that I keep next to the grinder.

If I held the blade with Vise Grips, I would probably burn the blade. This would remove the temper, and soften the blade. I cannot stress the importance of not over heating the blade. When you go to all the trouble of making a blade, then you draw the temper when grinding; you wasted all your work.

If you see any color from a heat buildup, you have gotten the blade too hot and you will soon learn how fast the blade heats up, and when to cool it. When grinding the cutting edge and point, be very careful, as it only takes seconds to heat. Stainless is bad about softening.

After rough grinding with 36 grits, put a 180-grit belt on the grinder. Repeat the process, and remove the 36 grit grinding marks from the blade. Be extra careful from now on, so you do not make any unnecessary mistakes.

FINISHING THE BLADE

Repeat the process with 240, 320, and 400 grit belts, and when you have finished with the 400-grit

belt, the blade should have a very good finish. You must be sure that the finish blade has a thickness of less than .020 on the cutting edge. This thickness is what makes a blade cut well and hold a good edge, but any thicker, sharpening it will be hard, will not hold an edge good, and probably wont cut good.

The exception to this, is when you want a knife that you can split game with, and on this kind of knife, the blade can be left .030 - .035 on the cutting edge. This type of blade will not hold an edge too good, but it will be a much stronger knife.

TEMPERING SPRINGS

On springs, I do not use the furnace to draw the temper. After hardening, I flatten the spring on a belt sander. This cleans up the surface so I can see the color.

Take the butane torch, and with a small flame start from the back of the spring. Heat the spring slowly, watching the colors. When the colors go through the whole range and up to dark blue, slowly move it down the spring. You will see the color go from dark blue to a light blue gray. Move the flame just fast enough to get this color.

When you have done this, let the spring cool, polish it again and repeat the process again. In several years of spring making, I have had only three springs break. The springs that broke had been over heated, and had very coarse grain.

FITTING THE FOLDING KNIFE

This is the most difficult part of knife making. This is where you take all the parts, and fit it into a working knife. You take the handles, with the bolsters attached, the blade, lock and fit them together, but if you do not have the hinge pinhole drilled in the handle, do it now.

Take the template that you used to mark out the handle, and clamp it in place on the handle. If you are using a larger style knife, drill this hole with an c inch drill. Be sure that you clamp the template on the both front and back. I have had many handle templates move when I only clamped it in one place.



WORKING PARTS OF A LOCKBACK

Turn on the drill press and slowly drill down through the hole in the template. Be sure that the drill bit is sharp, as I have had more than one bolster on small knives come off due to the heat buildup. The bolster will get hot enough to melt the solder if the drill is dull.



LINER AND HANDLE AFTER DRILLING

Now that you have the hole drilled, take the blade, lock, and put them together, clamping the blade in the vise holds them together. Take the lock, and gently tap in the notch on the blade. If it is fitted close, it will stick and stay in place.

Remove the blade and lock from the vise. Attach the blade to the handle by inserting an c inch pin. Now that you have this together, and the blade with the lock attached, line up the lock on the handle.



Line the top of the lock with the top of the handle. Take a clamp, and clamp the lock to the handle.

Go to the drill press, and put a 3/32-drill bit in the chuck. Now very carefully drill through the hole that you have in the lock. Drill slowly through the liner and handle material. If you try to drill too fast, it will split the handle material when it goes through, just apply enough pressure to keep cutting, but do not force it.

FITTING THE LOCK TO THE HANDLE

When drilled through, remove the clamps and templates. Leave the lock attached to the blade. Insert a 3/32-inch pin through the lock and handle so you can fit the spring retainer to the handle.

Finishing the lock on the bottom side now, if you did not harden the lock when you heat-treated the blade, do it now. We can harden it with a welding torch, or if you are using 01 tool steels, with a butane torch. Always preheat the end where the lock is, and dip it in brazing a flux or anti-scaling compound.

If you have not done it yet, finish the thickness of the lock to .005-006 smaller than the blade. You need the lock this much smaller so it does not bind up when you open or close the knife.

To do this, use the flat belt sander, and sand it down to the correct size. The blade is usually smaller than the lock, and spring retainer. The lock on the end, where you have the thumb recess cut, should also be a few thousands smaller for clearance.

When you have the lock taken down to size, put the worn-out 240 grit belt on the belt sander, and finish polishing the lock. Get a smooth a finish as possible. The smoother the finish the easier it will work, and the slower you will get wear.

FITTING THE SPRING RETAINER

Finish the metal on this retainer on the part that will be on the inside of the handles. The surface should be flat and square. This can be done on the end of the belt sander.



READY TO DRILL SPRING HOLDER

Set this on the end of the knife handle, and against the end of the lock. Mark where you want to drill the holes (two). We should drill the holes so they come no closer than an c inch from the outside edge of the handle.

Be careful that you do not drill the lower hole where the spring will be. You will look at the template to find this. The holes marked on the patterns should be close enough so there would be no problems.

DRILLING THE HOLES

Drill these holes with a 3/32-inch drill also. **BE CAREFUL HERE AS THIS RETAINER CAN GET AWAY FROM YOU AND CUT YOU AS IT SPINS AROUND**. I always hold the spring retainer with a vise grip or pliers, and even then, it will sometimes get away from me, so drill slowly and there should be no problems.

After we drill the holes, remove any burrs with a file. Have the blade and lock in position on the handle. Place the spring retainer on the handle, butting it against the end of the lock. Clamp the retainer in place, being sure that you leave enough clearance so you can drill one hole in the handle. Go to the drill press and use the same drill bit that you used to drill the first holes.

DRILLING THE HANDLE

Carefully drill down through the hole, and through the handle. Go through the handle material slow so you do not cause it to chip when it emerges on the other side. This is especially important if you are drilling bone, ivory, pearl, etc.



MARKING SPRINGHOLDER FOR CUTTING SLOT FOR SPRING

With the first hole drilled, remove the clamp and insert a pin in the hole to attach the spring retainer to the handle. Now get it lined again, and clamp it in place. Drill this hole and when completed, put a pin in place.

FITTING THE SPRING

You will need a piece of spring stock .093 thousands in diameter for the lock spring. This can be purchase from Brownells.

With the knife pinned and locked in the open position, take a piece of the spring wire and mark the retainer.

Holding the spring on the angle over the lock, and on the retainer, then with a scribe, and mark the retainer (spraying Dykem on the retainer is done so you can see the mark).



SLOT CUT FOR SPRING

We should position the spring so that it will be in the proper place on the lock; this is about a third of the distance back from the hole in the lock. You have to be sure there is enough clearance between the lock and spring, so when we unlock the knife it will not hit the spring.



When you have it marked, remove it from the handle and drill a hole where you want the end of the spring to be. Use a center punch and about d to 2 inch from the inside edge, carefully center punch it in the center of the spring retainer.

Go to the drill press again, and drill the 3/32 hole where you center punched it. The next thing to do is to cut the slot on the band saw, but be very careful doing this, as your fingers are very close to the blade.

Cut to the inside of both lines, and be sure that you will have enough metal left to file the cut marks flat. When you file it flat, you will also have to fit the spring to this slot so it will be a close snug fit. You will use thin needle files for this purpose.

When the spring fits snugly, hold the retainer with the spring in place over the holes in the handle. Take a pencil and put a mark on the spring at the place that we will cut it off, but do not worry if you did not get the slot in the right place, and the spring is too low.



SHOWING WHERE TO CUT OFF SPRING

Clip off the wire with a side cutter. Go to the belt sander and bevel the ends of the wire so there will not be any sharp edges. If the spring is too low, and it does not touch the lock, this will be easily corrected. Place the spring in the vise and bend it up slightly. Make the bend close to the retainer, but not next to it.

FITTING THE HANDLES TOGETHER

Now that you have the holes drilled, drilling the holes in the other handle will be necessary. To do this, carefully line up the handles and clamp them. Go to the drill press and drill through the existing holes. Now you can put the knife together and fit the blades.

FINISH FITTING THE KNIFE

Make sure that you have enough line up pins. You will need three 3/32-inch pins, and one c inch pin. Take one handle and insert a pin into a hole that holds the spring retainer. Set the spring retainer on the pin, and stick a pin into the other hole.

Take the other handle, and put it together on the pins, then take the lock and slip it between the handles and pin it. When you press the rear of the lock down, you should fill the spring pressure. Finish pushing it into the handle to be sure there is enough clearance on the spring retainer. If there is not, remove a little metal from the backside of the lock.

If everything fits well, take the blade, slip it in place, and pin it with an c inch pin. The lock should be all the way down in the notch blade. To be sure, use a small punch on the back and tap the lock all the way down.



SPRING SET AT PROPER ANGLE TO LOCK

Take a small C clamp and clamp the knife together on the bolster. This is to insure that the lock stays in place when you flatten out the back of the knife.



DRILLINGHOLES IN OPPOSITE HANDLE

FITTING IT TOGETHER

If you have all the parts finish and ready to assemble, we can put the knife together. There are two ways to finish the outside of the handles.

1. After all the pins are in place, the knife is placed on the belt sander, and the handles are finish flat. This type of finish gives a squarer handle with sharp edges that are not too comfortable, and a little hard on the pocket.

I do use this style some, as it is a little easier to hold on if your hands are cold and bloody. This style is a good candidate for a belt sheath.

2. The other way is to bevel the sides on the Wilton belt grinder. This puts a gentle radius on the out side of the knife that is very easy on the pocket. It will also make a neater and attractive knife.

If you choose the second option, the handles, and bolsters will need to be rough-radius before putting the knife together.



LINE-UP PIN USED WITH EITHER LOCK OR SPRING BACK KNIVES

The holes on the outside of the handles should be counter sunk a few thousands. This countersink can be purchase at any hardware store. The reason for this is when you peen the rivets, they will fill the counter sunk and hold the knife together.

Get a piece of 3/32 and c inch nickel silver rod or wire for the pin. Hold the spring retainer (if it is a lock back) or spring against the handle. Insert the 3/32-inch rod in the appropriate hole in the handle. Push it through the spring or spring retainer, and the other side of the handle.

Take a side cutter and clip off the rod, leaving about 3/32 inch sticking out on both sides. If you are working on a lock back, stick the pin into the other hole and clip off. Now insert the lock in place and insert the pin in place, and clip it off, but if you are making a spring back, do not pin the spring (in the center) yet. Take the blade and line it up with the hinge hole and insert an c inch rod in place, and clip it off.

Test the knife to be sure everything is fitted, as it should be.

If you are putting a spring back together, clamp the knife in a vise to compress the spring. Insert the steel lineup pin in place to adjust the spring. Take the 3/32-inch nickel silver rod, and put a slight taper on one end.



BACK OF KNIFE SANDED SMOOTH

This is to help you get it through the handle, as it will be a tight fit. Put a drop of oil on the pin, then remove the lineup pin and start the nickel silver rod into the hole, and push it as far as you can. Pliers or vise grips can be used to help you work the rod through the handle.

When you have it sticking out about 3/32 inch, clip off the rod. Open and close the blade to check to see if the fit is OK.

RIVETING THE KNIFE TOGETHER

You will now need to grind the pins off so we can peen them. The belt sander can be used for this and all the pins except the hinge pin should be ground off so only about .015 is protruding.

The hinge pin, is left with about 1/16 inch protruding on each side, the reason for this is with the slacking tool inserted you will need enough pin to fill out the counter sink.

Take a small ball peen hammer, and with the knife lying on its side on an anvil, peen the rear pins. Now, tap the pins lightly on the outside edge on the end all the way around the pin with your ball peen hammer. When the pin is rounded slightly, turn over the knife and do the other side. Keep rotating and peening a little more until the pins are tight.

Do not over peen, as you stand a good chance of splitting the handle material. Peen them just enough to make them snug.



KNIFECLOSED SHOWING SPRING AND BLADE PROTRUDING

PEEN THE CENTER PINS LAST

On the lock back, test the lock to see that it is not binding up. If it is, you may have to take off a little more metal on the table sander.



POINTS TO REMOVE TO FIT BLADE

PEENING THE BLADE

If the lock is working OK, push out the hinge pin slightly so we can put a sealer on the pin. The sealer

that I use is Loc-tite, and it is used to keep the pin from moving. With the pin recessed on one side about 1/16 of an inch, put a SMALL amount in the hole. Do the same on the pin on the other side.

DO NOT LET THE LOC-TITE GET DOWN TO THE BLADE. If this should happen, the blade will open and close very stiffly, or not at all.

USING THE SLACKING TOOL

Close the blade half way, and place the slacking tool between the blade and the liner. With the knife on the anvil, carefully peen the edges on the pin. Turn the knife over and repeat the process. Keep doing this until you have the pin peened very tight, and it has filled the counter sink in the bolster.

Remove the slacking tool, and open the blade until it locks. Wiggle the blade sideways to see if there is any play. If there is, insert the slacking tool back in place and peen the pin more. This time peen the pin more on the topside (lock side) of the handle. I use the flat side of the ball peen hammer for this, and hit the pin one or two good smacks.



FITTPNG THE SPRING

Remove the slacking tool and open the knife all the way again to check for side play. When you feel the blade getting tight about: of the way open, you have it right. This is a self-tightening design of the knife, and will keep the blade tight through years of use.

On a spring back, you do not tighten the blade this tight, as it needs the clearance to work well.

When you close the knife, it should snap shut with no binding, due to the clearance the slacking too gave it.



THE SLACKING TOOL FOR FITTING THE BLADE

Now, you can peen the center pin, if everything is working well; on the lock back, just peen it enough to fill the counter sink. Do not peen it tight or the lock will be too tight to work freely, but on the spring back, you do not have to worry about this.



FITTING BLADE IN HANDLE WITH SLACKING TOOL

FITTING THE SCALES TO THE BOLSTER

Clean up the inside of the bolster area with a file so it will be clean and fit the slabs perfectly. When you fit the scales to a knife that has a bolster or hilt, it will be a little tricky.

Carefully grind down the end of each scale with an 80-grit belt until it accurately fits against the hilt. Finish with a file to get them exact. Check the fit by holding it up to the light and see if there are any gaps between the scale, bolster or hilt.



DRILLING THE HOLES IN THE SLABS

After you have the scales fitted perfectly to the tang, you can now drill the holes for the metal rivets or pins. Clamp one slab onto the tang with a small C clamp, and with the slab side down, drill the holes in the slab using the predrilled rivet holes in the tang as a template. Remove the first slab, clamp the second one against the other side of the tang and repeat the above.

If you are going to use rivets instead of pins, drill out the countersink holes for the rivet heads.

CLAMPING THE SCALES

You will need three or four C clamps before you start, so have them ready. I have found that it makes it easier to install the handles to a knife that has a hilt if you modify a large clamp so that it can hold the scales up against the bolster. I use a hacksaw to cut a slot in the end of the C clamp. The other two or three other clamps will clamp the scales to the tang.

Make a trial run and clamp everything together to check the fit before mixing the epoxy! The modified clamp going lengthwise is only used when you have a bolster or finger guard on the knife.

PINS AND RIVETS

We hold the scales onto the tang with epoxy glue and brass rivets or pins. The rivets have a head on each end that mechanically hold the scales tightly against the shank. The pins simply form a metal connection between the two slabs, being held in place by the epoxy glue.



DIFFERENT TYPES OF RIVITS

DIFFERENT TYPES OF RIVETS

In using rivets, you have to countersink the rivet head flush with the outside of the slab. You need a drill bit that is precisely the size and shape of the rivet head and shaft for this.

The bit consists of a long pilot shaft that fits snugly into the rivet hole, and the two blades that cut away the material, forming the countersink hole. Countersinking bits are available in many sizes from a knife supplier, but you can construct a countersink bit from an existing flat wood drill bit. Reshaping is a simple machining task on the belt grinder.



RIVITS SANDED FLUSH IN HANDLE

Pins are the simplest means of holding the scales on. We make them from short lengths of brazing rod.

COUNTERSINK BIT

The angles of the blades that cut the countersink hole must be the same as the angle of the underside of the rivet head so there is no air space between the rivet head and the scale. The countersink is used with the drill press, and the outside of the rivet head should be set just below the surface of the scale.



REMOVING A RIVET

We include this as invariably you will mess up on setting a rivet, or you need to replace a rivet with a new one. What I do to remove the rivet is to drill out the rivet head with a 13/64-inch drill bit and then knock the shaft of the rivet through with a punch. If the rivet gets hot while we are drilling it, it will break the epoxy bond, and the rivet will spin. Prevent this by placing a file underneath the rivet. The rivet head will catch in the teeth of the file.

After we remove the rivet, you may have to clean out the countersink hole a little in preparation for the new rivet.

KNIFE MAKER RIVETS

There are rivets made for knife handles, and most are the screw on type, with long heads. After countersinking the heads, we bevel the portion remaining with the belt sander. These rivets are usually available at knife maker's suppliers.

Cutlers rivets consist of two pieces, and one half looks like a nail with a large head and a blunt point. The other half has an identical head, but its shank is a thick-walled tube. The parts are assembled by clamping them, forcing the solid part into the tube where they achieve a very solid grip.

Cutlers rivets are available in brass and nickel silver from knife making supplies.

In figuring the hole size for these rivets, choose a drill bit that is slightly larger than the tube shank. This will allow for the slight swelling that occurs when the two halves are pressed together. When the holes are prepared, the rivets can be set into place. Unless your handle is exceptionally thick or thin, the rivets are probably ready to use. When we squeeze the rivet halves together, their total length will be the length of the tube half plus the thickness of the two heads. Hold the rivet next to the handle to check to be sure that it is the proper length and it will work. Before setting, the rivet should stick up no more than 3/16 inch or it will be too long when set. The idea is to have the rivets fit as snugly as possible, but not too tight.



FINISHING THE OUTSIDE OF THE KNIFE

Use thirty-six grit belts on your belt sander (the 6 x 48-inch belts) for flatting the outside areas of the knife. If the style of the knife is such that it is flat on the back, flatten the back of the knife first. Remove the metal so there are no blade marks left on the back.

Usually, there will be enough material so the outside area can be cleaned up without having to take off much from the handles. When the back of the knife is flat, and (this should include the rear of the blade) slowly clean up the rest of the knife. With this coarse a belt, just take enough to get to the liner or handle.

If you are making a lock back, it is now time to cut the finger recess in the rear of the knife where you will open it. Pull the pin that holds the lock in place and remove the lock. If you have the Wilton square wheel grinder, use the 1 2-inch roller for cutting this groove.



RIVIT SET IN HANDLE

Very carefully, grind a groove in the back of the handle. Take the edge of this groove right up to the edge of the spring retainer, but not touching it. Cut it only deep enough so when the lock is pressed down it will unlock the blade.



When completed, take the knife apart, remove all the burs, and reassemble it without any knife parts. The reason for this is to be able to finish the outside of the bolster area. Go back to the thirty-six-grit belt sander (6 x 48 belt) and carefully finish the bolster area.

Be very careful that the bolster does not overheat, as the solder will melt. Dip the bolster area in water every few seconds to keep this from happening. When completed, use a 180 or a 240-grit belt to finish the outside of the handles, however do not do anything on the back for now. When you assemble the knife again, and then finish the back of the knife.

FITTING THE BLADE

Reassemble the knife again, and making sure that we have fully seated the lock. Go to the belt sander again and flatten the back again with 180 or 240-grit belt. This has to be fitted flush so you can get a good closing fit on the blade.

Now close the knife blade in the handle and see how much we should remove to get the proper fit. If you have left enough metal; we should raise the lock area 1/32 to 1/16 inch above the top of the handle in the bolster area. In addition, the blade should not be fully closed in the handle in the kick area (see picture) we should remove the metal to make the knife close. Just remember taking metal off the kick will cause the blade to close more in the handle.



SPRING BACK KNIFE

Taking metal off further back near the round part of the blade, will cause the lock to come back to flush when the blade is closed.

If the lock is extending a 32 of an inch or more, take metal off the kick area to lower the blade in the handle. This is done on the end of the 6×48 belt sander using a fine grit belt; use the radius that the roller of the sander will give you. From now on, it is trial and fitting, take off a little and then put the knife together and check the fit.

If the blade closes too much, and the lock is not flush, do not worry as it can probably be corrected. How can this be done? If you can remove a little more metal from the back, this will raise the blade a little.

If the lock goes below flush on the back of the blade when it is closed, you have a problem. The only way you can correct this is to have the lock seat deeper when the blade is open. Using an Arkansas stone, very carefully remove a little metal from the front of the lock.

When you get it to recess enough, flatten the back of the knife a little more so it will be flush. When you have the back flush when the knife is both open and closed, it is time to finish the blade for final fitting.

FITTING THE SPRING BACK

You need to get the end of the spring the right length now before you fit the blade. Now, pin the blade in the handle, and the spring in the rear hole.



PROPER FIT OF SPRING

With the spring in the notch of the blade, see how much the blade is pointing downwards.



It wants to be pointing down two to five degrees on a spring back. If it is pointing downward more

than that, you should take a little metal off the front of the spring until you get the right angle.

Do this a little at a time until you get it right. Remember that when we assemble the knife with a line up pin in the center hole, the blade will angle down 1 to 2 degrees more.

You need a line up pin, made from 3/32-inch spring wire and sharpened on one end, with an d inch taper. The end should be bent to a T shape so we can push it into the drilled hole.

When you have the line up pin made, assemble the knife, and clamp the handle in the vise so the spring is compressed a little. Now insert the pin through the hole in the handle and the spring.

Once you have this done, finish the knife as you would a lock back. The exception is that you should clamp the spring every time to remove the line up pin.

FINISHING THE BLADE

Now that the blade is fitted, you can finish the blade for final assembly. There are three options open to you for the blade finish.

1. The standard way to finish the blade is to polish it to a high finish. This is OK for a show knife, but for a work knife the finish will look bad in a year or so of use, what happens is the blade gets all scratch up with use.

2. If you want a work knife, you may want to use the Matte or soft satin finish. This finish is very rugged, and will not show many scratches due to hard use.

3. The third finish is for carbon tool steel and is a soft satin finish. Then after matting, we plate it with a corrosion resistant coating. I have used a coating called Marine Tuff for three years now on carbon steel with no rusting problems. An Electroless nickel process sold by Brownells is very good and will give you the same protection.

If you are going to polish the blade, it must be free from sanding belt scratches. When you are finish grinding the blade, you should use several grits sizes of belts. Each size should finish the blade a little finer.

Make sure that you remove the previous grinding marks before you go to the next finer belt. Be careful that you not change the lines of your knife as you grind. Occasionally, look down the length of the blade from the top to be sure that we center the point of the blade.

Finish the blade with 400 grit, and it will be ready to polish. They also make a cork belt that you put buffing compound on. This belt will remove many of the small shallow scratches.

If you want to eliminate much of your polishing, they even make belts with grits of 600 to 800. This will really put a fine polish on the blade. The one draw back of polishing the blade is, it will take an hour or so to do the job.

This translates into a higher cost on the finish product. This is important to remember, as the higher the cost, the harder it is to sell, and with a Matte finish, I can finish a blade in less than twenty minutes. When you have gotten the blade as good as you can on the belt grinder, you can then go to the buffing wheel for the final finishing.

Use a stitched buff in buffing with a good compound. For stainless steel they sell an aluminum oxide grease base compound to finish the blades. A good source for this is K & G Finishing Supplies (See Appendix). They have a choice of twelve different abrasives from which to choose, and they have just about everything that you would need to make knives.

Start with the coarser grits, and work up to the finer grits. Be careful about over polishing as you can get an orange peel finish.

When polishing blades, be extra careful so the blade does not catch the buff, always polish the lower half or three quarters of the blade, then flip it over and do the other side. If you let the top edge encounter the buff, it will grab the blade with such force; it can do serious harm.

DO NOT polish the blade if the edge is sharp. Always take the edge off first.

DO NOT hold on to the blade by the cutting edge, as it may grab and take your fingers off.

DO NOT have your feet under the blade when polishing. You might just have the blade sticking from your foot if it grabs and jerks from your fingers. I have had blades grab, and hit the floor so hard that it broke in two pieces, and chipped the floor.

If you can find meat cutters gloves, certainly buy them. They may just save you a trip to the hospital to sew the finger or fingers back on.

This is the most dangerous area of knife making. More accidents have happened here than in any other part of knife making.
FINAL FINISHING OF THE KNIFE

You now have the knife together, and it is working as it should be, or we hope that it is. You can now finish the out side of the knife. Go to the Wilton, and put on the pivot arm (the one with the 2 roller on the bottom, and the 3-inch roller on the top). Start with the 180-grit belt, and clean up the out side of the handles.

Remove the rivet, dents, and nicks from the outside of the handle. If you are going to keep the knife flat, omit this process. We will cover this next. Put enough radiuses on the handle to give about 1/16 clearance on the edges from the liner. This bevel will make a more attractive knife.

When we remove all the dents, nicks use a 240-grit belt to finish it a little smoother. You finish with a 320-grit belt to get the final finish before buffing.

FLAT-SIDED KNIFE

On this type of knife all that we need is go to the table sander, flatten it out, and remove the dents with a 180-grit belt. Usually, your local hardware store has belts of all different grits; so once you have the handle flatten out, go to the finest belt to remove all the scratches.

You will need to have a 1/16-inch flat all the way around the handle to break up the sharpness, and this can be done by hand or on the belt sander.

The edge of the knife needs to be finished on the sander to even up, and make everything flush. Use a fine grit belt to do this. The lock or spring may not be flush with the outside edges, and needs to be flushed on the back.

BUFFING THE HANDLES

The next step is to buff the handles to finish the knife. Use about 500 or finer grit for finishing the knife. Close the blade in the handle, and polish the bolster first on the front side of the bolster. You buff the bolster up to, but not where the handle material butts the bolster.

When you get all the scratches out, turn over the knife and do the other side. DO NOT BUFF TO THE TOP EDGE OF THE HANDLE AS IT MAY GRAB AND JERK THE KNIFE FROM YOUR HANDS. Always buff from the center of the blade to the lower edge.

Now polish the back part of the bolster down toward the handle. This will help keep the handle from dishing out where it joins the bolster. Polish this area only enough to get it scratch free, and no more. Finish polishing the rest of the handle and around the out side of the knife.

SHARPENING THE BLADE

I usually do this on the belt sander to get the main edge and angle. From there I go to the grinder that has the cardboard wheels on it.



It takes about 1 2 minutes to sharpen a knife this way to get a shaving edge on it. Just remember that sharpening the blade is the last operation, except oiling the knife.

When we sharpen the blade or blades, blow out the knife, and remove any buffing compound. Then oil the blade, spring or lock, the hinge area, and the outside of the knife. Work it a few times and you are done.

BUFFING AND POLISHING

POLISHING AND BUFFING WHEELS

They polishing wheels in general use are made of muslin, canvas, felt and leather. By changes in construction, offer to the operator wheels of varying flexibility that best suit the particular object to be finished and the condition of its surface.

Polishing wheels in widest use are made of woven cotton fabrics, the hardest wheel of this type being made of individual discs of canvas cemented together. The softest is composed of discs of muslin sewn together. The most popular wheels are composed of sewed sections of muslin discs fastened together by adhesives.

For economy, they often make these sewed sections of balanced pieces of muslin rather than full discs of cloth. As a class, cotton fabric wheels, because of their versatility and their relatively moderate in cost, and is the most commonly used medium for general all-around polishing.

Pressed felt wheels, available in densities from rock hard too extra soft, the face of the wheel must be kept true and be uniform in density over its entire surface. The face of a felt wheel can be easily contoured to fit irregularly shaped articles. Because of their higher initial cost, they generally restrict them to the finer abrasive grit sizes.

Solid leather wheels of walrus and bull neck leather are tough but resilient, with a springy open grain, and are favored for the fine polishing required in cutlery and gun work. Wood wheels covered with leather belting are popular for flat surfaces where they need a minimum of flexibility. Wheels made of sheepskin discs are used where they need great flexibility and less density. In the harder sheepskin wheels, they cement the individual discs together while in the softer types they hold the discs together only by hand sewing.

Practically all the materials mentioned above which are used in disc form for the production of polishing wheels can be used in a different manner in the production of the so-called compress wheel. In this wheel, small pieces of leather or woven fabric are placed in a rigid center section so their edges are perpendicular to the side of the wheel. There are no seams following the direction of rotation and more precise polishing can be done than with any other type of built-up wheel.

Various grades of flexibility are available for each type of material used and, with the stiffer density woven fabric compress wheels in particular. They can obtain a degree of fine polishing that cannot be duplicated with wheels of different construction.

MAKING A WORK BLADE

When you are making a knife for this purpose, you should also do another step. With the blade polished, take a butane torch and draw the temper on the back of the blade.

This is done by using a small flame on the back of the blade. Start in the lock area, and holding the EDGE of the flame on the spine, or edge. As the edge heats, you will see color starting to appear on the blade. Do not let this color go to the cutting edge.

The color on the back of the blade should be purple and light straw about HALFWAY to the cutting edge. This will take some practice, and it is best done on an old blade first. Keep a pan of water handy as you draw the back. If the color is getting too close to the cutting edge, dip the cutting edge in the water.

Draw the temper all the way down the blade. Dip the cutting edge into the water anytime the color is getting past HALFWAY. When done, you will have a blade that is very tough, but with a hard edge. We can abuse this type of knife (Heaven Forbid) without too much chance of breaking. This method can only be used with carbon steels. On any type of stainless steels this will not work.

With this done, we can now go to the fitting of the blade.

SATIN FINISH

The satin finish is for me the best and most practicable way to finish the blade. For a work knife, this finish is very hard to beat. To satin finish a blade, you will need a small bead blaster. Most industrial supplies outlets sell these. Get a bag of fine mortar sand from a building supply outlet. You can make up a large container to reuse the sand, or use a small container and bead blast the blade outdoors.

Make sure that your air compressor has at least 80 lbs. of pressure, and better yet 100 lbs. Put on a dust mask, and holding the blade about 4 inches away from the nozzle. Squeeze the lever and matte the blade evenly on both sides. Hold the blade up to the light to check to see if you missed any spots.

The finish should be even over the entire blade, but this finish is normally too coarse to look good. This is why I use a wire wheel to finish it. This finish will hold oil to help protect it from rusting. I have also used an auto wax on the blade to protect it from bloodstains, etc. This makes an excellent finish for stainless tool steels.

SHAPING THE HANDLE

The belt sander is what I use for shaping the handle quickly. Make the surface of the handle and the tops of the rivets flush. Do not take too much off the heads of the rivets. You will be going over them three or four more times, so leave enough material on them.

Rough shape around the edges, forming the handles basic shape and making the steel flush with the scales. Use a coarse grit belt for the first shaping processes, about 36 grit. We now file and sand the outer edge of the handle to make it flush with the steel of the tang. We then refine and rounded the shape of the handle with rasps, files, and sandpaper.

If you have a belt sander with a narrow belt, there may be a space where the belt is free from the metal backing. If so, this will be invaluable for finishing the underside of the handle.

FINGER GRIPS

If you want fingers to grip, the Wilton Belt sander will cut these as it has rollers down to 1". Form the finger grips as neatly and precisely as possible. You want the depressions to be rounded but the ridges to be well defined, not just lumps.

Have fun.